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ACCIDENTS IN THE PETROLEUM INDUSTRY OF OKLAHOMA 1915–1924

BY

H. C. FOWLER

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ACCIDENTS IN THE PETROLEUM INDUSTRY OF OKLAHOMA, 1915–1924

By H. C. Fowler

INTRODUCTION

Every occupational accident to a workman represents an economic loss to his employer. The question of charging this loss to industry is no longer debatable, and the injured person does not have to assume the burden of proof. During the past 15 years workmen's compensation laws have become effective in all but six States. This fact shows clearly that industrial development has been veering away from the erroneous idea that an accident is a "regrettable circumstance" or a "lamentable mishap."

The Bureau of Mines realizes the need for condensed statistical information on accidents in the petroleum industry, and engineers of the bureau have directed much effort toward investigations that will place such data in a readily comprehended form before operators, safety engineers, superintendents, and the men who are engaged in hazardous work. Furthermore, such studies accord with the spirit of the organic act establishing the Bureau of Mines. That act charged the bureau with the duty of making investigations and disseminating information to improve health conditions, increase safety, and aid economic development in mining and other mineral industries.

PURPOSE OF REPORT

This paper has a threefold purpose:

1. To present a few important facts regarding the workmen's compensation law of Oklahoma that bear directly upon the compilation of accident statistics and studies of the problem of accident prevention.

2. To summarize, in suitable reference form, available statistical information on the accident experience of the Oklahoma petroleum industry.

3. To analyze this statistical information briefly so that it will show the petroleum industry the need for persistent effort in accident prevention, and for continued study of additional facts that affect accident costs.

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This report was prepared in cooperation with the State of Oklahoma. Full acknowledgment is made to the State Industrial Commission of Oklahoma for use of data and for the cooperation given in preparing this report. Mrs. F. L. Roblin, chairman, and H. C. Myers and Edgar Fenton, commissioners, read the manuscript and offered helpful suggestions. Mrs. Alice Goff, statistician, aided in checking the figures.

Free use has been made of figures pertaining to enrollment of petroleum-industry employees, which were taken from a bulletin of the Department of Labor, State of Oklahoma.

The writer is indebted to Arch L. Shaver, formerly of the Indian Territory Illuminating Oil Co., Bartlesville, Okla., for constructive criticism, and to Miss A. B. Fowler, Sebastopol, Calif., for suggestions regarding presentation of the material.

R. A. Cattell, chief helium engineer of the Bureau of Mines; F. M. Brewster, assistant chief petroleum engineer; H. C. Miller, of the San Francisco, Calif., office; and Ben E. Lindsly and I. B. Williams, of the Petroleum experiment station, Bartlesville, Okla., gave valuable assistance in the preparation of the paper through helpful suggestions and criticisms. Miss Ruth Brown and C. L. Cushman, of the Bartlesville station, prepared the charts.

HISTORICAL RÉSUMÉ

Oklahoma became a State in 1907. Eight years afterward, in 1915, resources had been developed to such an extent that the number of industrial employees can be conservatively placed at 80,000.[1] The need of a satisfactory method for equitable adjustment of the claims of injured workmen became so apparent during these years that the workmen's compensation law of the State of Oklahoma was passed by the fifth legislature in regular session. Oklahoma was the thirty-first State to adopt such a compensation law. The first members of the commission, three in number, qualified on July 1, 1915, and the law became effective September 1, 1915. During the first year the constitutionality of the act was contested, but was upheld by the State Supreme Court. (In re claim S. L. Adams, October, 1916.)

The commission compiled and published a report covering its first year, September 1, 1915, to August 31, 1916. The accidents were classified by industries to show the number of awards under the act and the amounts expended for compensation and medical attendance and also classified as to the part of the body affected. This report constitutes the first available record of accident occurrence

[1] State Industrial Commission of Oklahoma, First Annual Report: Jan. 1 1917, p. 5.

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in Oklahoma. Similar reports were published annually to include the fifth year, 1919–20, but lack of funds prevented the further distribution of this information in printed form. However, the data for 1920–21, contained in a rough draft, have been made available for use in this paper through the courtesy of the commission.

Recently the commission has been able to resume statistical compilations, and the ninth annual report, for 1923–24, has been released. Their importance should not be overlooked, because they form a valuable reference in research on accident-prevention problems.

INFORMATION IN REPORT

The data set forth in this paper include condensed figures on accident occurrence and the resulting compensation and medical expense in the Oklahoma petroleum industry from September 1, 1915, to August 31, 1921, and from September 1, 1923, to August 31, 1924, as listed in annual reports of the State industrial commission. The figures for the petroleum industry have been compared with the listed totals for the State during the same periods. These listed totals refer to all industries of the State where men are employed in "manual or mechanical work, or labor, connected with or incident to one of the industries, plants, factories, lines, occupations, or trades"[2] specified in the workmen's compensation law. Employees engaged in clerical work exclusively, those engaged in agriculture, horticulture, dairying, or stock raising, and those operating any railroad engaged in interstate commerce are not included. The subtotals for the petroleum industry are included therein. As a matter of record, the available figures contained in the fifth biennial report of the State Industrial Commission of Oklahoma for "All industries," for 1921–22 have been added. In addition, the data have been segregated to show the subtotals and percentages for the three main departments of the petroleum industry, namely, drilling and production, pipe lines, and refineries. A résumé of additional information on the accident experience of Oklahoma is appended to the State records. These later figures were obtained from the files of the State industrial commission by the Bureau of Mines and are based upon a study of the compensable accidents in the petroleum industry for the calendar year 1923.[3] By definition, a compensable accident is one for which compensation is allowed under the workmen's compensation law.

WAITING PERIOD

Under the provisions of the Oklahoma workmen's compensation law a "waiting period" is specified. This waiting period is the length of time that intervenes between the date of injury and the

[2] Oklahoma workmen's compensation law (as amended), effective June 30, 1923.

[3] Fowler, H. C., "A review of the petroleum accident records in Oklahoma during 1923": Thirteenth Annual Safety Congress, Louisville, Ky., 1924.

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date when compensation becomes effective. The law, as enacted in 1915, provided for a waiting period of 14 days. On June 28, 1919, this period was shortened to 7 days, and compensation was made retroactive to the day of injury if the disability continued for 21 or more days. At this time, also, maximum compensation per week was increased from $10 to $18. Effective June 30, 1923, the waiting period was shortened from 7 to 5 days, and, regardless of the length of disability, the law requires no compensation for the first 5 days after the injury.

REPORTED AND COMPENSABLE ACCIDENTS

On account of the foregoing provision relative to a period of waiting before the payment of compensation begins, many accidents that are reported to and filed by the State industrial commission do not develop into compensable cases. In a study of accident statistics it is therefore necessary to differentiate between reported accidents and compensable cases.

All accidents that cause lost time should be reported, because many so-called minor injuries develop serious complications through neglect. An accident report brings the injury to the attention of a person who is fitted to render or to recommend the proper treatment.

Infection, or "blood poisoning," as it is commonly called, is closely related to injuries that should be given serious consideration. The result of lack of proper attention to an open wound may be realized from the fact that out of the records of 3,728 compensable accidents in the Oklahoma petroleum industry during 1923, 5.1 per cent stated specifically that infection was directly responsible for the loss of time or prolonged the period of convalescence. The severity of many such injuries could have been reduced and the employee could have returned to his work with less physical suffering and a larger monthly pay check if proper treatment had been given the injury soon after it occurred. Furthermore, if an apparently slight injury becomes serious, the early history of the case has been recorded before the facts are obscured by subsequent conditions.

One broken leg, however, may represent a greater loss than 100 cuts and bruises. This statement means that a study of compensable cases as well as reported accidents is necessary in an economic investigation to determine the true status of accident costs.

Compensable accidents should be studied in relation to increased or decreased numbers, year by year; in relation to reported accidents; and, wherever possible, in relation to the number of employees and amounts of time lost. Only by this procedure can one obtain definite knowledge of their frequency and severity.

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DEATHS

Another provision of the Oklahoma law that bears directly on a study of the economic effect of accidents is that applying to death claims. The Oklahoma law is the only workmen's compensation law that provides no compensation for the dependents of men who are killed while engaged in industrial labor. An amendment was referred to the people in August, 1916, to change this part of the act, but it was defeated. Accordingly the State industrial commission is left without jurisdiction when an injured man dies from the effect of an accident. The reports of deaths used in this paper were sent to the commission by the companies of their own volition, and the total undoubtedly is incomplete.

Most oil companies make a fair and reasonable adjustment of death claims, and the dependents of fatally injured workmen are seldom forced to sue for compensation; but many operators agree with the following statement in the first annual report of the State Industrial Commission of Oklahoma: "The law can never fulfill its true commission until it covers death cases."

TABULATION OF DATA

The statistical data contained in this paper have been arranged in one table. This table is a recapitulation of the annual reports of the State Industrial Commission of Oklahoma with reference to the petroleum industry, as a whole and by departments, and to all industries to which the workmen's compensation law applies. Columns showing unit costs and percentages are appended.

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TABLE 1.—*Recapitulation, for all industries and for the petroleum industry and its branches, of the annual reports of the State Industrial Commission of Oklahoma (columns 1–10 and 12); unit costs of accidents, computed from data in annual reports (columns 11 and 13); and percentages of accidents and costs, computed from data in annual reports (columns 14–21)*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Number of accidents causing lost time									Costs of accidents				Percentages							
	Temporary disability			Permanent disability			Number of accidents			Compensation		Medical attendance [2]									
	Days less than waiting period	Days more than waiting period	Total (sum of columns 1 and 2)	Permanent partial disability	Permanent total disability	Total (sum of columns 4 and 5)	Compensable accidents (sum of columns 2 and 6)	Total reported (sum of columns 3 and 6) [1]	Deaths [2]	Total cost	Average unit cost (column 10 ÷ column 7	Total cost	Average unit cost (column 12 ÷ column 8)	Total accidents reported (department to petroleum industry)	Compensable accidents (department to petroleum industry)	Permanent disabilities (department to petroleum industry)	Deaths (department to petroleum industry)	Compensable accidents to total reported	Permanent disability to compensable accidents	Compensation (department to petroleum industry)	Medical attendance (department to petroleum industry)
ALL INDUSTRIES	14 days or less	More than 14 days																			
Sept. 1, 1915–Aug. 31, 1916	7,245	1,748	8,993	161	3	164	1,912	9,157	($)	[3]$108,713.71	$56.86	[4] $91,546.96	$10.00					20.9	8.6		
Sept. 1, 1916–Aug. 31, 1917	12,281	2,547	14,828	361	4	365	2,912 [5]	15,193	141	318,681.46	109.44	188,015.12	12.38					19.2	12.5		
Sept. 1, 1917–Aug. 31, 1918	16,213	3,297	19,510	401	7	408	3,705	19,918	195	452,988.88	122.26	210,775.24	10.58					18.6	11.0		
Sept. 1, 1918–Aug. 31, 1919 [6]	10,197	3,476	13,673	330	6	336	3,812	14,009	219	551,280.69	144.62	245,171.59	17.50					27.2	8.8		
	7 days or less	More than 7 days																			
Sept. 1, 1919–Aug. 31, 1920	16,893	5,320	22,213	496	5	501	5,821 [7]	22,714	130	729,870.73	125.39	236,292.33	10.40					25.6	8.6		
Sept. 1, 1920–Aug. 31, 1921	14,604	7,846	22,450	405	9	414	8,260	22,864	85	1,085,036.92	131.36	226,160.49	9.89					36.1	5.0		
Total Sept. 1, 1915–Aug. 31, 1921	77,433	24,234	101,667	2,154	34	2,188	26,422	103,855	770	3,246,572.39		1,147,951.73									

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Sept. 1, 1921–Aug. 31, 1922	(?)	(?)	(?)	434	10	444	(?)	25,636	(?)	1,458,081.74	(?)	649,540.24	25.34					(?)	(?)		
Sept. 1, 1922–Aug. 31, 1923 [4]	(?)	(?)	(?)	(?)	(?)	(?)	11,287	34,908	(?)	1,795,648.83	159.10	799,119.60	22.90					32.3	(?)		
Sept. 1, 1923–Aug. 31, 1924	11,403	33,830	45,233	585	8	593	34,423	45,826	(?)	1,387,855.00	40.30	579,462.41	12.65					75.1	1.7		
PETROLEUM INDUSTRY	14 days or less	More than 14 days																			
Sept. 1, 1915–Aug. 31, 1916	1,911	438	2,349	56	1	57	495	2,406	(?)	33,510.22	67.69	25,768.22	10.71	26.3	25.9	34.8	(?)	20.6	11.5	30.8	28.1
Sept. 1, 1916–Aug. 31, 1917	3,420	780	4,200	142	2	144	924	4,344	53	110,610.49	119.70	85,604.34	19.71	28.6	31.7	39.5	37.6	21.3	15.6	34.7	45.5
Sept. 1, 1917–Aug. 31, 1918	5,553	1,124	6,677	157	1	158	1,282	6,835	57	158,674.18	123.77	105,843.47	15.48	34.3	34.6	38.7	29.2	18.8	12.3	35.0	50.2
Sept. 1, 1918–Aug. 31, 1919 [6]	3,947	1,303	5,250	146	1	147	1,450	5,397	58	215,404.32	148.55	108,434.58	20.09	38.5	38.0	43.8	26.5	26.9	10.1	39.1	44.2
	7 days or less	More than 7 days																			
Sept. 1, 1919–Aug. 31, 1920	5,840	1,767	7,607	213	1	214	1,981	7,821	36	240,771.00	121.54	112,156.54	14.34	34.4	34.0	42.7	27.7	25.3	10.0	33.0	47.5
Sept. 1, 1920–Aug. 31, 1921	3,991	2,895	6,886	195	1	196	3,091	7,082	29	446,042.19	144.30	83,063.70	11.71	31.0	37.4	47.3	34.1	43.6	6.3	41.1	36.7
Total, Sept. 1, 1915–Aug. 31, 1921	24,662	8,307	32,969	909	7	916	9,223	33,885	233	1,205,012.40		520,870.85									
Calendar year 1923 [5,9]	[10](?)	3,440	(?)	288	0	288	3,728	(?)	[11](?)	376,266.00	100.93	(?)	(?)	(?)	(?)	(?)	(?)	(?)	7.7	(?)	(?)
Sept. 1, 1923–Aug. 31, 1924	5,025	6,883	11,908	245	2	247	7,180	12,155	(?)	450,110.00	63.00	(?)	(?)	26.4	20.7	41.6	(?)	58.7	3.5	32.4	(?)
DRILLING AND PRODUCTION	14 days or less	More than 14 days																			
Sept. 1, 1915–Aug. 31, 1916 [12]	1,414	366	1,780	54	1	55	421	1,835	(?)	28,690.39	68.14	21,626.04	11.79	76.3	85.0	96.5	(?)	22.9	13.1	85.6	83.9
Sept. 1, 1916–Aug. 31, 1917	1,845	549	2,394	106	2	108	657	2,502	27	76,559.14	116.68	56,585.73	22.62	57.6	71.1	75.0	51.0	26.3	16.4	69.3	66.1
Sept. 1, 1917–Aug. 31, 1918	2,623	712	3,335	108	1	109	821	3,444	39	113,757.43	138.56	59,046.59	17.14	50.4	64.1	69.0	68.4	23.8	13.3	71.7	55.8
Sept. 1, 1918–Aug. 31, 1919 [6]	1,895	869	2,764	107	0	107	976	2,871	28	143,010.80	146.53	65,437.18	22.79	53.2	67.3	72.8	48.3	34.0	11.0	66.4	60.3

[1] Includes reported deaths.
[2] Records not complete.
[3] Paid by self-insured companies, in addition, $15,311.05.
[4] Paid by self-insured companies, in addition, $6,446.36.
[5] Claims, compensation denied, 12; reports of accident, but no time lost, 173; total reports, 15,378.
[6] Effective June 28, 1919, law amended as follows: (1) Waiting period shortened from 14 days to 7 days. (2) Compensation made retroactive to date of injury for 21 or more days' disability. (3) Maximum compensation per week increased from $10 to $18.
[7] Total shown, p. 30, 4th Annual Report, 22,348; not complete.
[8] Effective June 30, 1923, law amended as follows: (1) Waiting period shortened from 7 days to 5 days. (2) Compensation not payable for first 5 days of injury.
[9] Compiled by Bureau of Mines from commission files.
[10] January only, 375.
[11] Jan. 1 to June 30 only, 19.
[12] Pipe line figures included in drilling and production figures for Sept. 1, 1915, to Aug. 31, 1916.

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TABLE 1.—*Recapitulation, for all industries and for the petroleum industry and its branches, of the annual reports of the State Industrial Commission of Oklahoma (columns 1–10 and 12); unit costs of accidents, computed from data in annual reports (columns 11 and 13); and percentages of accidents and costs, computed from data in annual reports (columns 14–21)*—Continued

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Number of accidents causing lost time									Costs of accidents				Percentages							
	Temporary disability			Permanent disability			Number of accidents			Compensation		Medical attendance [2]									
	Days less than waiting period	Days more than waiting period	Total (sum of columns 1 and 2)	Permanent partial disability	Permanent total disability	Total (sum of columns 4 and 5)	Compensable accidents (sum of columns 2 and 6)	Total reported (sum of columns 3 and 6) [1]	Deaths [3]	Total cost	Average unit cost (column 10 ÷ column 7	Total cost	Average unit cost (column 12 ÷ column 8)	Total accidents reported (department to petroleum industry)	Compensable accidents (department to petroleum industry)	Permanent disabilities (department to petroleum industry)	Deaths (department to petroleum industry)	Compensable accidents to total reported	Permanent disability to compensable accidents	Compensation (department to petroleum industry)	Medical attendance (department to petroleum industry)
	7 days or less	More than 7 days																			
Sept. 1, 1919–Aug. 31, 1920	1,665	1,114	2,779	128	1	129	1,243	2,908	23	$136,809.91	$110.06	$46,974.41	$16.15	37.2	62.7	60.3	63.9	42.7	10.4	56.8	41.9
Sept. 1, 1920–Aug. 31, 1921	1,648	1,156	2,804	97	1	98	1,254	2,902	20	201,311.91	160.54	47,098.59	16.23	41.0	40.6	50.0	69.0	43.2	7.8	45.1	56.7
Total, Sept. 1, 1915–Aug. 31, 1921 [12]	11,090	4,766	5,856	600	6	606	5,372	16,462	137	700,239.58		296,768.54									
Calendar year 1923 [4,9]	[13] (?)	2,454	(?)	232	0	232	2,686	(?)	[14](?)	297,638.00	110.81	(?)	(?)	(?)	72.0	80.6	(?)	(?)	8.6	79.0	(?)
Sept. 1, 1923–Aug. 31, 1924	2,703	4,579	7,282	161	0	161	4,740	7,443	(?)	298,237.00	62.91	(?)	(?)	61.2	66.5	65.2	(?)	63.7	3.4	66.3	(?)
PIPE LINES	14 days or less	More than 14 days																			
Sept. 1, 1915–Aug. 31, 1916 [12]																					
Sept. 1, 1916–Aug. 31, 1917	296	56	352	15	0	15	71	367	5	17,343.29	244.27	9,943.18	27.09	8.4	7.7	10.4	9.4	19.3	21.0	15.7	11.6
Sept. 1, 1917–Aug. 31, 1918	534	104	638	17	0	17	121	655	5	13,718.88	113.38	11,210.98	17.12	9.6	9.4	10.8	8.8	18.5	14.0	8.6	10.6
Sept. 1, 1918–Aug. 31, 1919 [4]	655	166	821	13	0	13	179	834	10	22,817.01	127.47	15,037.06	18.03	15.5	12.3	8.8	17.2	21.5	7.3	10.6	13.9

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	7 days or less	More than 7 days																	
Sept. 1, 1919–Aug. 31, 1920	2,266	313	2,579	48	0	48	361	2,627	5	46,896.23	129.91	35,046.11	13.34	33.6	18.2	22.4	13.9	13.7	13.3	19.5	31.2
Sept. 1, 1920–Aug. 31, 1921	1,294	860	2,154	52	0	52	912	2,206	4	119,877.46	131.44	3,868.95	1.75	31.1	29.5	26.5	13.8	41.3	5.7	26.9	4.7
Total, Sept. 1, 1916–Aug. 31, 1921 [12]	5,045	1,499	6,544	145	0	145	1,644	6,689	29	220,652.87		75,106.88									
Calendar year 1923 [8,9]	[13](?)	443	(?)	29	0	29	472	(?)	[14](?)	37,384.00	79.20	(?)	(?)	(?)	12.7	10.0	(?)	(?)	6.1	10.0	(?)
Sept. 1, 1923–Aug. 31, 1924	653	900	1,553	30	0	30	930	1,583	(?)	51,187.00	55.04	(?)	(?)	13.0	13.0	12.1	(?)	58.7	3.2	11.4	(?)
REFINERIES (INCLUDING GASOLINE PLANTS)	14 days or less	More than 14 days																	
Sept. 1, 1915–Aug. 31, 1916	497	72	569	2	0	2	74	571	(?)	4,819.83	65.13	4,142.18	7.25	23.7	15.0	3.5	(?)	13.0	2.7	14.4	16.1
Sept. 1, 1916–Aug. 31, 1917	1,279	175	1,454	21	0	21	196	1,475	21	16,608.06	84.74	19,075.43	12.93	34.0	21.2	14.6	39.6	13.3	10.7	15.0	22.3
Sept. 1, 1917–Aug. 31, 1918	2,396	308	2,704	32	0	32	340	2,736	13	31,197.87	91.76	35,585.90	13.01	40.0	26.5	20.2	22.8	12.4	9.4	19.7	33.6
Sept. 1, 1918–Aug. 31, 1919 [6]	1,397	268	1,665	26	1	27	295	1,692	20	49,576.51	168.06	27,959.74	16.52	31.3	20.4	18.4	34.5	17.4	9.2	23.0	25.8
	7 days or less	More than 7 days																	
Sept. 1, 1919–Aug. 31, 1920	1,909	340	2,249	37	0	37	377	2,286	8	57,064.86	151.36	30,136.02	13.18	29.2	19.1	17.3	22.2	16.5	9.8	23.7	26.9
Sept. 1, 1920–Aug. 31, 1921	1,049	879	1,928	46	0	46	925	1,974	5	124,852.82	134.98	32,096.16	16.26	27.9	29.9	23.5	17.2	46.9	5.0	28.0	38.6
Total, Sept. 1, 1915–Aug. 31, 1921	8,527	2,042	10,569	164	1	165	2,207	10,734	67	284,119.95		148,995.43									
Calendar year 1923 [8,9]	[13](?)	543	(?)	27	0	27	570	(?)	[14](?)	41,244.00	72.36	(?)	(?)	(?)	15.3	9.4	(?)	(?)	4.7	11.0	(?)
Sept. 1, 1923–Aug. 31, 1924	1,669	1,404	3,073	54	2	56	1,460	[15] 3,129	(?)	100,687.00	68.96	(?)	(?)	25.8	20.5	22.7	(?)	46.7	3.8	22.3	(?)

[1] Includes reported deaths.
[2] Records not complete.
[6] Effective June 28, 1919, law amended as follows: (1) Waiting period shortened from 14 days to 7 days. (2) Compensation made retroactive to date of injury for 21 or more days' disability. (3) Maximum compensation per week increased from $10 to $18.
[8] Effective June 30, 1923, law amended as follows: (1) Waiting period shortened from 7 to 5 days. (2) Compensation not payable for first 5 days of injury.
[9] Compiled by Bureau of Mines from commission files.
[12] Pipe-line figures included in drilling and production figures for Sept. 1, 1915, to Aug. 31 1916.
[13] January, 1923, only: Production, 274; pipe lines, 26; refineries, 75; total, 375.
[14] Jan. 1–June 30, 1923, only: Production, 15; refineries, 4; total, 19.
[15] Total shown, p, 21, 9th Annual Report, 12,409, in error.

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Statistical information is helpful only when taken in the light of what it may reveal through study and comparison, and due weight must be given to known or expected conditions. Some of the percentages hereinafter listed may seem to vary between wide limits. The right to claim compensation under the Oklahoma law prevails for 1 year from the date of injury, provided notice of injury has been given to the commission and to the employer within 30 days after the accident (secs. 7301 and 7292). Therefore, accidents that occur in the latter part of one year may be reflected in compensation paid in the following year.

The amendments as to the length of the waiting period have had some effect on the data shown in columns 1 and 2 of Table 1. Inasmuch as these changes have been effective on dates other than the beginning of the years for which the tabulations are listed, it has been impossible to differentiate between the totals of longer and shorter waiting periods, other than to indicate when the changes occur by footnotes in the table.

The deaths listed in column 9 of Table 1 are included in the total number of accidents reported for each year (column 8). The figures in column 9 are not complete, but they are presented to indicate the cost to the industry in human lives.

Although the figures in the tabulations are subject to correction, the bureau feels that the percentages obtained therefrom are within the bounds of reasonable error. Since the primary purpose of the figures is to establish a basis of comparison, they are worth considering for the facts they reveal, because knowledge gained from study of the facts is essential to the efficient growth of business.

ANALYSES OF CURVES FOR ACCIDENTS IN PETROLEUM AND OTHER INDUSTRIES

To aid in comparing the data and analyzing their meaning, the more important items presented in Table 1 have been plotted (figs. 1 to 15) with consecutive years as abscissas. Where due to lack of information, a break occurs in any curve, a straight dotted line has been drawn to connect the two known points, and where data for the calendar year 1923 overlap the compensation year, September 1, 1923, to August 31, 1924, the 4-month period has been cross-hatched. No attempt has been made to approximate the missing figures by the law of averages or by other mathematical calculation. The total period of time covered by the report has not been long enough to establish any definite criteria, but the curves, as plotted, show many interesting facts.

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RELATION OF TOTAL ACCIDENTS TO COMPENSABLE ACCIDENTS

Curves *a* and *b* in Figure 1 show a general upward trend in the total number of reported accidents. This general increase in reported accidents is to be expected on account of the industrial development of Oklahoma. The decrease of 6,000 reported accidents for all industries, including 1,400 for the petroleum industry in 1918–19, below the figures for 1917–18 is partly explained by the fact that many industries were forced to reduce appreciably the total number of men employed, although the output of some industries was maintained at the maximum owing to war demands. In 1919–20, when

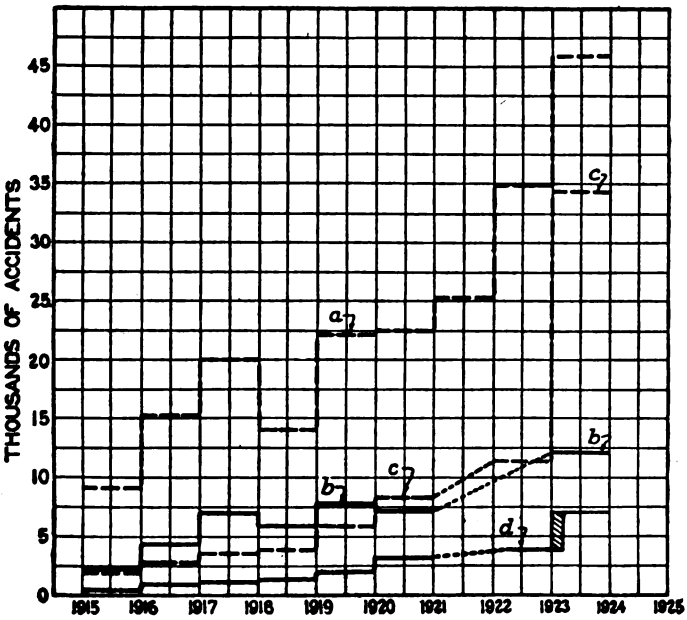

FIGURE 1.—Total number of reported accidents in Oklahoma, *a*, for all industries and *b*, for petroleum industry; and total number of compensable accidents, *c*, for all industries, and *d*, for petroleum industry

many men of military age had returned to civil life, the number of accidents reported took an upward trend again. Working conditions were not stabilized immediately after demobilization, and a large labor turnover took place during this time of readjustment. Frequent changes in personnel contribute to the frequency of accidents. This factor should be given serious consideration in the study of accident prevention.

The increment of increase for all industries during 1922–23 and 1923–24 is much greater than in previous years. During the 9-year period the total number of accidents reported to the commission per year increased from 9,157 to 45,826. This means that there were

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five times as many accidents reported in 1923–24 than there were in 1915–16. Curve *b* shows that this same relation held true in the petroleum industry. The accidents in 1923–24 in the petroleum industry, 12,155, were approximately five times the number, 2,406, for 1915–16.

After studying these conditions pertaining to total reported accidents it is necessary to study the compensable cases during the same period in order better to understand the economic significance of the whole accident problem.

Curves *c* and *d* in Figure 1 show the total number of compensable accidents for all industries and for the petroleum industry. Both curves show a stepped increase for each succeeding year. In 1918–19, when the number of reported accidents decreased, the number of compensable accidents showed a slight increase. The reason for this variance is found by referring to column 18, Table 1. Compensable cases continued to form about 20 per cent of the total reported accidents for the petroleum industry and all other industries as well until 1918–19. During this year the amended law shortened the waiting period from 14 to 7 days and increased the amount of compensation. As a logical sequence, the percentages of compensable cases to reported accidents increased to 27 per cent and held above 25 per cent for 1919–20. In 1920–21 this percentage for the petroleum industry increased to 43.6 per cent and for all industries to 36.1 per cent. In the period 1923–24, during which the law was amended to shorten the waiting period from 7 to 5 days (June 30, 1923), the percentage of compensable cases to reported accidents was 58.7 per cent in the petroleum industry and 75.1 per cent in all industries.

Reporting cases to commission.—Only from the complete records of succeeding years can the definite results of this relation of compensable accidents to total reported accidents be determined. Probably these percentages will never again reach the lower limits of the first years of the workmen's compensation law. When the law first became effective, many employers doubted its practicability; some employees looked upon it with suspicion; insurance carriers suddenly found a situation presented to them concerning which they had no past experience; and the public knew little or nothing about the operation of such a law. The human mind is so constituted that it is always reluctant to give up the old way for something new and untried. However, as the working principles of the law became better known and the equity of standardized compensation was established in the minds of all concerned, more cases were reported to the commission.

Enrollment in petroleum industry.—Complete data are not available from which to compute actual frequency and severity rates, but the

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following figures [4] indicate the industrial trend of the petroleum industry:

Number of companies replying to questionnaire in 1921

Production	146
Pipe lines	13
Refineries	50
Gasoline plants	19
Total	[5] 228

Number of field and plant employees reported by 282 companies [1]

Branch of industry	1914	1920	1921
Production	3,749	19,938	12,836
Pipe lines	634	4,374	3,038
Refineries and gasoline plants	151	5,974	4,432
Total	4,534	30,286	20,306

[1] The numbers apply to Sept. 1 of each year.

If the records of these 228 companies are taken as a fair indication of the trend of the Oklahoma petroleum industry, the total enrollment of employees in 1920 was 6.7 times greater than in 1914; but the enrollment of 1921 was 33 per cent less than the enrollment of 1920.

Comparison of these enrollment figures with the data in Table 1 helps to show the status of accidents in the petroleum industry during these years. The number of reported accidents in the petroleum industry (column 8, Table 1, and curve *b*, fig. 1) for the year ended August 31, 1920, was 3.2 times greater than for the year ended August 31, 1916. On the other hand, the decrease in the number of reported accidents for the year 1920–21 was only 9.4 per cent, as compared with an enrollment decrease of 33 per cent for the same year.

A similar comparison of enrollment and compensable accidents shows greater divergence. The number of compensable accidents in the petroleum industry (column 7, Table 1, and curve *d*, fig. 1) for 1919–20 was four times greater than in 1915–16. However, in 1920–21, when the number of total reported accidents decreased 9.4 per cent and the enrollment decreased 33 per cent, the number of compensable accidents increased 56 per cent above that of the previous year.

This comparison of percentages forces the conclusion that the accident rate for the petroleum industry was above normal in 1920–21. Data are not available on enrollment of employees to make similar comparisons for succeeding years.

[4] Oklahoma Department of Labor, Bureau of Labor Statistics Bulletin: Nov. 1, 1921, p. 2.

[5] Of this total 53 were operating in 1914.

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ACCIDENTS IN PETROLEUM AND OTHER INDUSTRIES

Curve *a* of Figure 2 shows the total number of reported accidents in the petroleum industry expressed in percentage of the total number of reported accidents in all industries. Likewise, curve *b* of Figure 2 shows the number of compensable accidents in the petroleum industry, expressed in percentage of the number of compensable accidents in all industries. Both curves show that the petroleum industry is chargeable with over 25 per cent of the total reported and of the compensable accidents. Curve *a* reaches a peak in 1918–19 at 38.5 per cent, from which point it gradually declines to 26.4 per cent at the end of the 9-year period. On the other hand, curve *b* rises gradually until 1918–19, when a high point of 38 per cent is reached. The curve then drops to 34 per cent for 1919–20, but at the end of the 6-year period, or for 1920–21, the

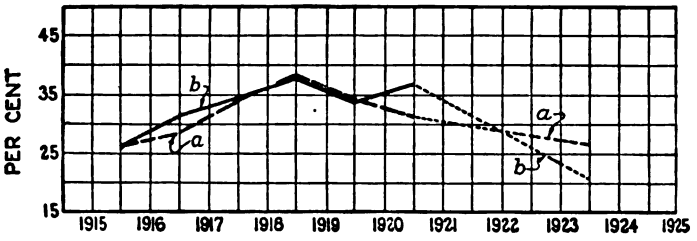

FIGURE 2.—*a*, Percentage of total reported accidents in Oklahoma petroleum industry with regard to all industries; *b*, percentage of compensable accidents in petroleum industry with regard to all industries

curve again rises to 37.4 per cent In 1923–24 this curve falls to 20.7 per cent—the only time during the 9-year period when petroleum accidents were less than one-fourth of all the accidents for which compensation was paid.

PERMANENT DISABILITY ACCIDENTS FOR PETROLEUM AND OTHER INDUSTRIES

Figure 3 shows the number of permanent disability accidents for all industries and for the petroleum industry. Curve *a*, Figure 4, shows the percentages of all permanent disability accidents that are chargeable to the petroleum industry. This line zigzags upward from an initial point of 34.8 per cent to 47.3 per cent in 1920–21, and then falls off to 41.6 per cent in 1923–24.

The percentage curves shown in Figures 2 and 4 indicate that the petroleum industry is an important factor in the accident experience of the State, but reference should be made to the curves in Figures 4, *b*, and 5 before a reason for these high percentages is sought.

Figure 5 shows the percentages of permanent disabilities included in the compensable cases. Although the number of permanent

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disabilities has increased, following in a general way the increase in the number of compensable accidents (see figs. 1, *c* and *d*, and 3), there has been a decline in the percentage of permanently disabled workers to the total number receiving compensation. This decline is gratifying.

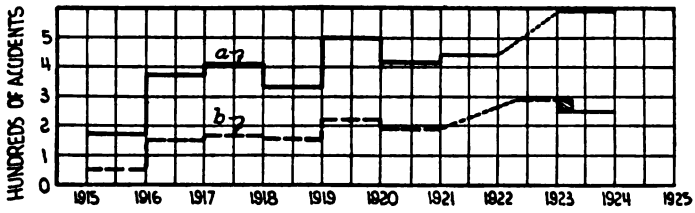

FIGURE 3.—Total number of permanent disability accidents: *a*, For all industries; *b*, for petroleum industry

Index of permanent disability.—Throughout this report the number of permanent disability cases per hundred compensable acci-

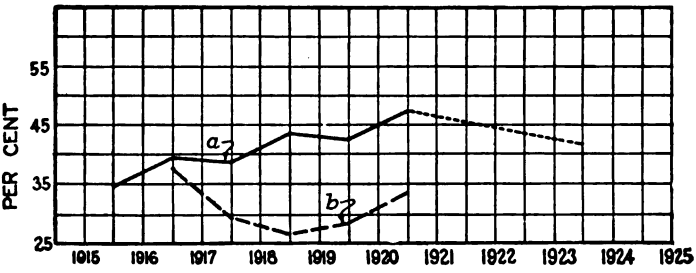

FIGURE 4.—*a*, Percentage of permanent disability accidents in Oklahoma petroleum industry with regard to all industries; *b*, percentage of listed industrial deaths in petroleum industry with regard to all industries

dents will be called "the index of permanent disability." For example, if 200 employees of a company received compensation for injuries during a year and if 10 of these employees were either partly

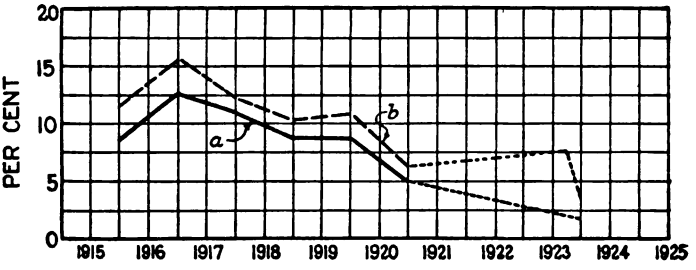

FIGURE 5.—Percentage of permanent disabilities with regard to compensable cases: *a*, For all industries; *b*, for petroleum industry

or totally disabled for life, the company's "index of permanent disability" for the year would be 5.

Further study of the two curves in Figure 5 shows that curve *b*, representing the index of permanent disability for the petroleum

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industry, is higher than curve *a*, representing the index for all industries. The average index for the petroleum industry during the 6-year period 1915–16 to 1920–21 is 11.1; for all industries the corresponding index is 9.1. In 1923–24 the index for the petroleum industry dropped to 3.5 and that for all industries to 1.7.

The importance of this index is brought out by the bureau's review[6] of accidents in the Oklahoma petroleum industry for the calendar year 1923. According to the records of the State industrial commission there were 3,728 compensable accidents, of which 288 were permanent disabilities. The index of permanent disability is 7.7, but these 288 permanent disability cases were responsible for the equivalent of 66,404 lost days, or 40.8 per cent of all time losses. In arriving at this figure for total days lost the accidents were weighted in accordance with the schedule of the Oklahoma law, and no death cases were included in this weighting.

Weighting of permanent disability.—An example of weighting for permanent disability follows: The reduced earning power of a man who loses his hand by accident is weighted as the equivalent of 200 weeks' compensation under the Oklahoma law. An injury of this nature to one man may mean that eventually he will become a public charge; to another, the loss of a hand may develop dormant talents of which he had no knowledge. He may become of more worth to himself and to the public than he was before the accident. Whether this weight should be 200 weeks or 3,000 days, or some other figure, depending upon the age and occupation of the injured, is a mooted question and can be solved only by study of accident experience extending over a long period of time. Any scale of permanent disability weighting is subject to criticism, but the records of many rehabilitated men show that the present method, now accepted by the majority, has helped to counteract in a large degree the losses caused by permanent injury.

A definite weighting schedule gives a basis for comparison, and the same standardized schedule should be adopted by all States, so that greater progress in the study of safety can be made. Furthermore, whether a skilled mechanic, upon the loss of his hand, becomes a beggar or an expert accountant does not alter the fact that permanent disabilities are far reaching and lasting in their effect. Industry pays for the loss of a man from its organization, and no industry should be content to allow the line representing its index of permanent disability to take an upward trend.

Weighting of deaths.—The number of deaths reported during any year for which records were obtainable for the petroleum industry of Oklahoma did not fall below 25 per cent of the number of deaths

[6] Fowler, H. C., "A review of the petroleum accident records in Oklahoma during 1923": Thirteenth Annual Safety Congress, Louisville, Ky., 1924

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reported for all industries (fig. 4, *b*). Although these percentages can not be considered accurate, due to the incompleteness of the records, their meaning should not be ignored. In fact, deaths are of such importance to an industry that columns of figures showing numbers of fatal accidents are inadequate to convey their true significance if used alone. Every fatal accident in industry suddenly shuts off for all time a potential source of human endeavor. The actual days lost for an individual death would be equal to the working-life expectancy of the man whose working period is thus suddenly shortened.

In individual cases the working-life expectancy of one man differs from that of another between wide limits. It is evident, however, that the mean of all working-life expectancy is represented by some figure that falls between that of an average man at the beginning of his useful period of constructive labor and that of an average man upon his retirement from useful service. Retirement may be voluntary, or it may be enforced by old age or other reasons. In any case, working-life expectancy is less than the life expectancy of an individual. The average period of gainful work between the age of first employment and that of retirement can be expressed most readily in number of days; the actual figure should be based upon the findings of a detailed study of the productive period of the average man's life.

This method of weighting death cases may seem to be a cold and matter-of-fact way of considering loss of human life, but it should be remembered that the purpose of such a method is to give the mind a definite scale of measurement.

Many students of safety problems question the use of an arbitrary equivalent weighting of 6,000 days [7] for an industrial death in tables of time lost; yet in any total based upon this figure, or upon any other figure taken as a death-equivalent weight, a person should read more than the tabulations set out in type—something of the irreparable loss of actual days taken from the life of a man. Other men will eventually replace those who are killed, but the sum of human endeavor is lessened by the amount that each man failed to produce in material gain and in happiness.

HIGH ACCIDENT RATE OF PETROLEUM INDUSTRY

The foregoing study shows that the petroleum industry is responsible for a large percentage of the compensable accidents, permanent disabilities, and industrial deaths in Oklahoma. The main reason why the percentage curves show a high average for the petroleum industry in relation to all industries is the fact that there are more

[7] Recommended by the committee on statistics and compensation insurance cost of the International Association of Industrial Accident Boards and Commissions.

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accident exposures in the recovery, transportation, and refining of oil than in the average industry employing an equal number of men. The nature of the work and numerous occupations within the petroleum industry contribute largely to the facts pointed out by Figures 2, 4, and 5.

ALLOCATION OF EMPLOYEES

Employers should consider the aptitude of the men they employ. The derrick floor, pump station, or refinery inclosure is not a place for those physically unfit or mentally sluggish. Every employment manager, member of the medical profession, or other person engaged in the work of passing upon a man's mental or physical condition should weigh the qualifications of the applicant carefully against the work to which he may be assigned. Too often a man unwell in mind or body takes up a task for which he is not qualified. Not only he but others are endangered because no one knows that he is weak and not able to withstand an unexpected strain. Medical examinations have not had unanimous indorsement by all companies. This may be the result of a feeling harbored by many men that health is entirely a personal matter and that any steps taken by a company to determine a man's well-being are an infringement upon his personal liberty. Social, economic, and industrial relations have become too involved, the endeavors of society are too interrelated for this idea to prevail. Education will gradually break down this prejudice. Some day medical examinations will be considered an essential part of the employment program of all companies, and a long step will have been taken to reduce accidents.

COSTS

The monetary cost of accidents can ordinarily be listed under one of three main headings: (1) Compensation and insurance; (2) medical treatment; and (3) the economic equivalent of the time lost by injured employees. The last item is even more significant than the other two, although the growth of its direct cost is not so easily traced.

To the employee it means decreased income, fewer comforts, and in many instances actual deprivation of the necessaries of life for himself and for his dependents.

To the employer it means a loss of production, increased overhead expense, and a general decrease in morale, efficiency, and economy of operation.

To the public it means depression in the economic welfare that follows the well-being of individuals and normal exchange of commodities.

Statistics dealing with this phase of the problem are available for the calendar year 1923 only, therefore no graphs can be plotted.

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However, the following data for the Oklahoma petroleum industry during 1923 are presented as a basis for future comparisons.

The number of compensable accidents (3,728), reflects a loss of 162,718 days and an equivalent loss of $960,000 income to injured employees. This sum was computed on the basis of actual daily pay roll against days of lost time. These 3,728 cases cost $376,266 in compensation.

If an organization employing nearly 4,000 men suspended operations for a month and a half and all of its employees suffered enforced idleness during that time, more than passive interest would be shown. Not only would those directly affected by this "shut down" be greatly concerned, but the public would ask for information regarding the causes of such an occurrence. It is important, then, to consider seriously the economic loss that results if 3,728 men are injured and each man is unable to perform constructive work for an average of 43.6 days. It is important also to remember that these men and their dependents have suffered privations brought about by a reduction of 14.5 per cent in their normal annual earnings.

A comparison of the figures in column 10, Table 1, shows that the amount of compensation paid out has increased rapidly. The petroleum industry paid $33,510.22 in compensation from September 1, 1915, to August 31, 1916. In 1920–21 the cost was $446,042.19, or 13.3 times greater than in 1915–16, although the number of compensable accidents (column 7, Table 1) in 1920–21 was only 6.2 times greater than in 1915–16. For all industries compensation was 10 times greater, and the corresponding number of compensable cases 4.3 times greater in 1920–21 than in 1915–16. In 1923–24 the compensation paid for accidents in the petroleum industry was $450,110—an increase of only $4,067.83 over that paid in 1920–21, although the number of compensable accidents more than doubled. The year 1922–23 marks the high point of compensation for accidents in all industries; the total paid was $1,795,648.83. In 1923–24 the amount decreased to $1,387,855, although the number of compensable accidents was three times greater than in the year before.

Costs for petroleum and other industries.—The curves in Figure 6, representing the average costs of compensation per case for the petroleum industry and for all industries, give additional information on the subject of accident costs. The points on the curves have been determined by dividing the total amount of money paid as compensation by the total number of compensable accidents for any given year. Undoubtedly the high point of the curves in 1918–19 was affected by the fact that the waiting period was shortened from 14 to 7 days, and the maximum compensation per week was increased from $10 to $18. The average unit costs for the petroleum industry and for all industries in 1918–19 were $148.55 and $144.62, respec-

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tively. In 1919–20 the average unit compensation for the petroleum industry was $27 less, and for all industries $19 less, than in 1918–19. In 1920–21 the average compensation increased again, but did not go as high as in 1918–19. The average cost of compensation per case for the petroleum industry for the calendar year 1923 was $100.93, and for 1923–24 this average cost dropped to $63.

Figures from the State industrial commission show that the year 1922–23 marked the high point of average cost per case for all industries, when the curve went to $159.10; but in 1923–24 there was a

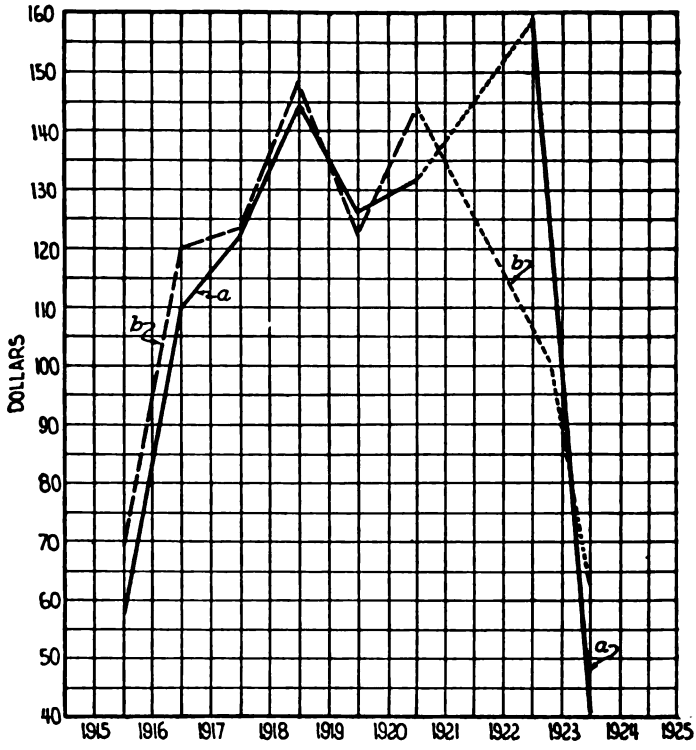

FIGURE 6.—Average cost of compensation per case: *a*, For all industries; *b*, for petroleum industry

marked drop to $40.30 per case—the lowest point reached during the 9-year period.

Average cost of medical treatment.—The average costs of medical treatment per case are more stable than the average costs of compensation. The curves are shown in Figure 7. The points on the curves were determined by dividing the total medical expense by the total number of accidents reported for any given year. This method is not strictly correct, as many reported accidents did not require the services of a physician. On the other hand, if the total medical expense were divided by the total number of compensable

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accidents, the unit cost obtained would be more than the actual cost, because an injured man often receives medical attention and returns to work before the end of the waiting period. Furthermore, there is question as to the accuracy of the amounts shown for medical expense. Probably the figures are low, and the following quotation [8] may give a reason for the upward inclination of the curve for all industries in 1921–22:

> Heretofore we have not required the respondents and insurance carriers to file with us an accurate statement of the medical expenses incurred during the year. This year [1921–22], however, we obtained reports or statements which showed to the penny the amount expended by respondents and carriers for the treatment and care of injured workmen.

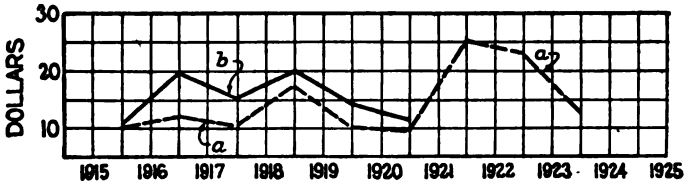

FIGURE 7.—Average medical expense per case: *a*, For all industries; *b*, For petroleum industry (records not complete)

In both compensation and medical unit costs the curves representing the oil industry are several dollars above the curves representing all industries.

The high point for unit cost of medical treatment was reached in 1921–22 at $25.34 for all industries; the cost in 1923–24 dropped to $12.65. The average over the 9-year period, based on the figures at hand, is $14.62. No data are available for the petroleum industry with regard to medical expenses after 1920–21.

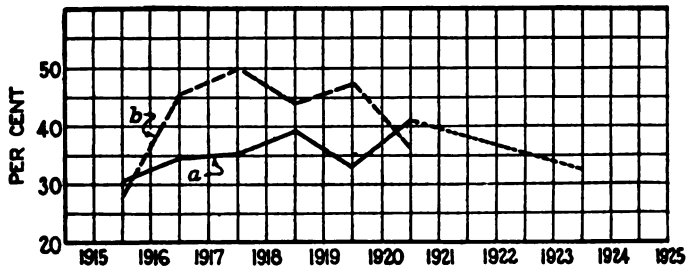

FIGURE 8.—Percentage of compensation (*a*) and of medical expense (*b*) for the petroleum industry with regard to all industries

Percentage of total medical expense and compensation paid by petroleum industry.—Figure 8 should be studied in connection with curves *a* and *b* of Figure 2. The top curve *b* of Figure 8 shows the medical expense for the petroleum industry, expressed as a percentage of the medical expense for all industries. The highest point for medical expense was reached in 1917–18, when 50.2 per cent of the

[8] State Industrial Commission of Oklahoma, Fifth Biennial Report: Jan. 1, 1923, pp. 3 and 4.

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total expense recorded was charged to the petroleum industry. From this point the curve declines irregularly. There is little or no similarity between this curve in Figure 8, based on dollars expended for medical service, and the corresponding curve *a* in Figure 2, based on total number of accidents.

Curve *a* (fig. 8) shows the percentage of total compensation expense borne by the petroleum industry. This curve follows the same general upward trend throughout the 6-year period, 1915–16 to 1920–21, and then drops to a lower figure in 1923–24 that would be expected after noting the percentage curve *b* (fig. 2), based upon the number of compensable injuries.

During the first year compensation paid to injured workmen in the petroleum industry was 30.8 per cent of the total compensation of the State. This percentage increased year by year until the percentage curve representing the petroleum industry reached 39.1 per cent in 1918–19. The following year, when industries had partly reestablished their normal working conditions, the curve decreased to 33 per cent, but in 1920–21 it again increased to a high point of 41.1 per cent. In 1923–24 there was a decrease to 32.4 per cent.

SUMMARY OF DATA ON ACCIDENTS FOR ALL INDUSTRIES AND PETROLEUM INDUSTRY

The data in Table 1 on accidents for all industries and for the petroleum industry show that—

1. Reported and compensable accidents in Oklahoma have followed an increasing upward trend.

2. This increase is largely due to the industrial development of the State and to a tendency to report more accidents, although it is apparent that the rapid rate of increase for the petroleum industry has been above normal.

3. At the beginning of the 9-year period accidents in the petroleum industry comprised more than one-fourth of the accidents in all industries. This proportion for compensable accidents and permanent disabilities increased until 1920–21, but in 1923–24 there was a marked decrease.

4. The rate of decrease of permanent disability compared with compensable accidents for all industries and for the petroleum industry is gratifying. Every effort should be made to keep this class of accidents at a minimum. Permanent disabilities cause the largest amount of lost time.

5. Unit costs of compensation for all industries and for the petroleum industry increased steadily until 1918–19. From this peak they fluctuated considerably until the end of the 9-year period,

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where both were less than at the beginning of the period. Unit medical costs have remained relatively constant.

6. The average cost per case for compensation and medical service was more for the petroleum industry than for all industries.

Many other interesting facts might be brought out by further comparisons. It is hoped that these data and curves will furnish a basis of comparison for those studying the problem of accident prevention. The records of every organization will show trends that vary from those shown in this paper; but careful analyses to find reasons for these variations will help to solve accident-prevention problems for an organization.

Use of statistics.—Analyses based upon past experience as told in figures should be correlated with other safety research. Such studies will aid in developing methods of education and safe practice that may be applied to raise the standard of individual organizations.

In a discussion of the safety problem an operator once said, "I am for safety—if it doesn't cost anything." Certainly this operator was not aware that during the first 6 years of the workmen's compensation law (1915–16 to 1920–21, inclusive) accidents cost industries of Oklahoma $3,246,000 in compensation and more than $1,147,000 in medical expense; nor could he have been aware of the fact that the petroleum industry was responsible for approximately one-third of the accidents that occurred during this 6-year period. Tabulations recently published in the ninth annual report of the State industrial commission indicate that since 1920–21 compensation and medical expense has cost nearly $2,000,000 a year. It is reasonable to suppose that the annual expenditure for accidents will never again reach the low limits of the first years of the workmen's compensation law unless a concentrated effort is made to curtail accidents.

It would be interesting to know how many of the 1,730 organizations in the State of Oklahoma that are directly concerned with the production, transportation, and refining of petroleum have prorated to themselves the 33,885 reported or 9,223 compensable accidents, that have occurred in the petroleum industry during the 6 consecutive years from 1915–16 to 1920–21. These accidents cost $1,205,000 in compensation and more than $520,000 in medical expense. During the same period more than 233 deaths for which no charge is recorded occurred in the petroleum industry. If data were available for each of the succeeding years, a much greater cost would be reflected in the totals.

Remembering these figures, and realizing that they tell only part of the story, every producer, drilling contractor, rig builder, and casing-crew boss, every pipe-line contractor and transportation manager, and every gasoline-plant operator and refiner should ask himself the question, "What does it cost me if I am not for safety?"

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The $1,725,000 compensation and medical attendance awarded has done much to alleviate the suffering and detrimental effects of injury to employees of the petroleum industry. Many records are on file that tell this fact conclusively. Other large sums to be spent in the future for compensation and medical treatment should have the approval of every right-thinking person. As an investment for future return, such as the prevention of recurring accidents, this money is a loss because it has been spent irrevocably.

Importance of safety measures.—No one claims that all accidents can be prevented, but the number of accidents can be reduced. To do this an investment of effort and money must be made.

It is good business for every organization to train its employees in safety measures and to make installations that are consistent with good engineering and safe practice. An organization which gives such training and provides safe working places is investing for the future welfare of its employees and for added returns through the elimination of hazards.

ANALYSES OF CURVES FOR ACCIDENTS IN DEPARTMENTS OF PETROLEUM INDUSTRY

The data on departments of the petroleum industry in Table 1 are corollary to those pertaining to the petroleum industry already presented in that table. To show graphically the distribution of accidents and costs in the departments of drilling and production, pipe lines, and refineries, additional percentage curves have been plotted (figs. 9 to 15, inclusive).

RELATION OF TOTAL ACCIDENTS TO COMPENSABLE ACCIDENTS

Figure 9 shows the total number of reported accidents for each department expressed in percentages of those for the whole petroleum industry, and Figure 10 shows the compensable accidents in like manner. The general similarity of the curves in the two figures is apparent. For the first year under the workmen's compensation law (1915–16) accidents in the pipe-line department (*b*) were listed with those of drilling and production (*a*). For this reason the curves representing drilling and production probably start at a point higher than actual conditions would warrant. Accordingly, the lines joining the points representing the first year with those of the second year for this department have been dotted.

Accidents in drilling and production (curve *a*, fig. 10) were responsible for more than 60 per cent of the compensable accidents in the petroleum industry until 1920–21, when the line dropped to 40.6 per cent—its lowest point. However, the 1923 accidents (calendar year) show an increase to 72 per cent and for the year September 1,

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1923, to August 31, 1924, were 66.5 per cent. Refinery accidents (curve *c*) took precedence over those in the pipe-line department by an appreciable amount until 1919–20, when the two curves merged and followed the same general trend; both reached a peak in 1920–21 but decreased at the end of the 9-year period. At no time during

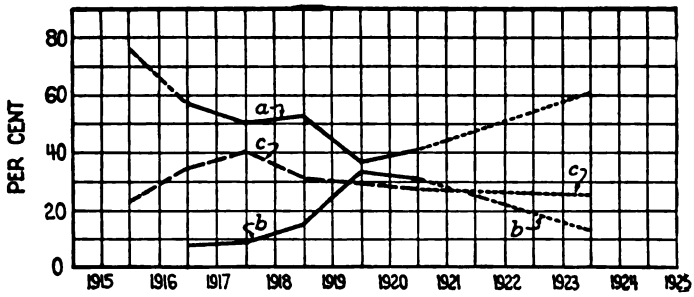

FIGURE 9.—Percentage of reported accidents in each department of petroleum industry with regard to those of petroleum industry: *a*, Drilling and production; *b*, pipe lines; *c*, refineries

the period did the number of compensable accidents for refineries or pipe lines exceed 30 per cent of the total for the industry. The averages over the period are 21 and 15 per cent, respectively. These percentages seem logical when the relative number of men employed in each of the three departments in 1921 is considered. An estimate

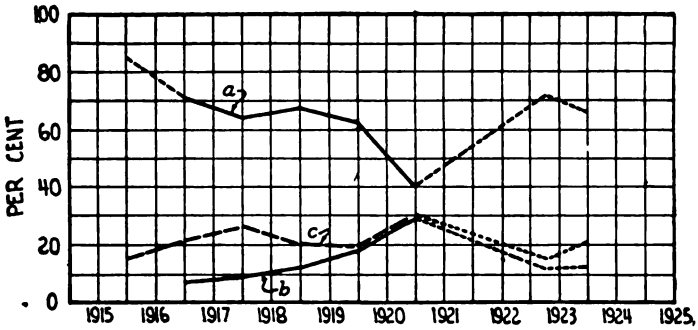

FIGURE 10.—Percentage of compensable accidents in each department of petroleum industry with regard to those of petroleum industry: *a*, Drilling and production; *b*, pipe lines; *c*, refineries

based upon the reports of 228 companies indicates that producing operations employed 63.2 per cent of the men, refineries and gasoline extraction plants 21.8 per cent, and pipe lines 15 per cent.

PERMANENT DISABILITY ACCIDENTS FOR DEPARTMENTS OF PETROLEUM INDUSTRY

The "index of permanent disability," or number of permanent disability cases per hundred compensable accidents, is shown for each department in Figure 11. Refineries have the lowest index curve for the three departments. The high point on this curve is

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10.7 for the year 1916–17. From there the curve gradually declines to 4.7 in 1923. Pipe lines started at the highest point of all the departments in 1916–1917, with an index of 21.0. For the next two years the decline was rapid, and the curve reached 7.3—nearly two points below either of the other curves. During 1919–20, however, an intermediate peak of 13.3 broke the descent of the curve until 1920–21, when it again fell and continued until the end of 1923 on a line less than drilling and production but more than refineries. For the year September 1, 1923, to August 31, 1924, all three departments were very close to the 3.5 mark. During times of steady growth of the industry as a whole it is logical that production should be responsible for a relatively larger percentage of permanent disability accidents than either of the other departments. This is explained if weight is given to the fact that operation and maintenance of refineries and pipe lines involve fewer serious hazards than are attendant upon drilling and the development of oil properties;

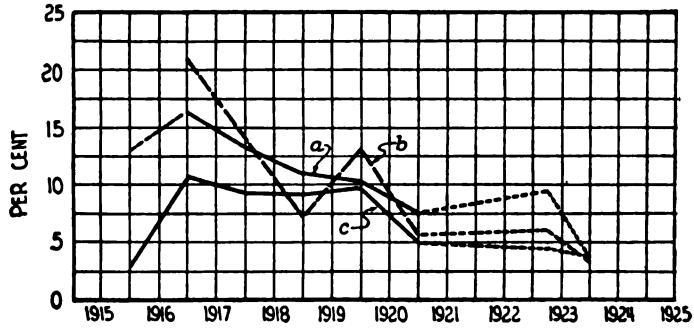

FIGURE 11.—Percentage of permanent disability for each department of petroleum industry with regard to petroleum industry: *a*, Drilling and production; *b*, pipe lines; *c*, refineries

also, refineries and pipe lines are more easily organized for safety. It is more difficult to impress men with the thought of safety if they are scattered over a producing field than if they are grouped in stabilized communities about industrial plants or stations. Drilling and production operators should realize this fact. When forces are scattered, the men should be called together periodically to receive instruction in the fundamental principles of safety.

AVERAGE COST OF COMPENSATION

The unit costs of compensation for the three departments (fig. 12) show great variations for which there are few apparent reasons. Probably the high unit cost of compensation for pipe-line accidents during 1916–17 is due to the fact that many of the men injured during the latter part of the first year did not receive their compensation until the beginning of the following year, although the record of their injury was included in the table under drilling and production as

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noted on pages 7–8. Weight should be given to this fact, because this unit cost is more than 45 per cent higher than any other unit cost listed. Although there is a great variation in all of these curves, it

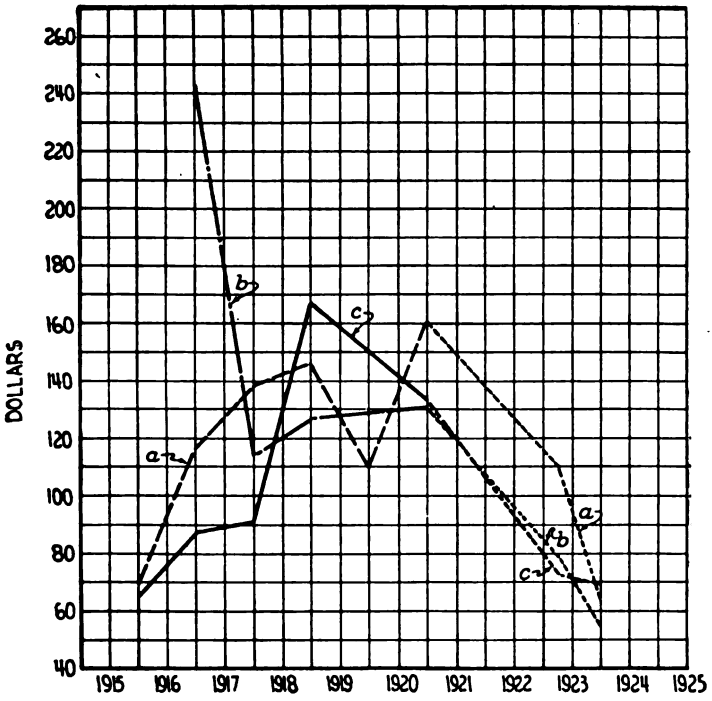

FIGURE 12.—Average cost of compensation per case for each department of petroleum industry: *a*, Drilling and production; *b*, pipe lines; *c*, refineries

is proper to show them because they may have considerable bearing upon the whole problem of economic operation in the future. The later points show a tendency of the curves to merge.

AVERAGE COST OF MEDICAL TREATMENT

Unit medical costs have been more stable (fig. 13). The low point reached in 1920–21 by the pipe-line department has been plotted according to the figures shown by the State industrial commission.

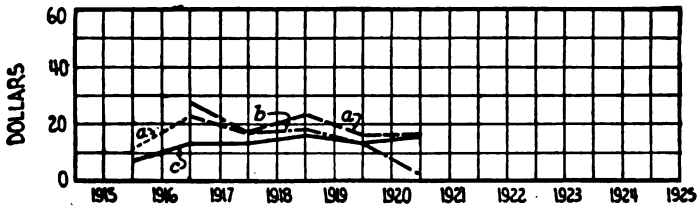

FIGURE 13.—Average medical expense per case for each department of petroleum industry: *a*, Drilling and production; *b*, pipe lines; *c*, refineries

Data for years following this period will probably show that this point is below its true position. It does not seem logical that the number of cases should increase 150 per cent over that of the previous

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year and that the total amount of compensation should be only 11 per cent of that of the previous year. This discrepancy is probably the result of incomplete records. No data were available for the years following 1920–21.

PROPORTION OF COMPENSATION AND MEDICAL TREATMENT PAID BY VARIOUS DEPARTMENTS

The percentages of compensation cost and medical expense for the three departments, compared to the whole petroleum industry, are shown in Figures 14 and 15. The drilling and production department (curve *a*) takes the highest place on the scale in both figures. At no time during the period does either curve for this department fall below 40 per cent of the total for the petroleum industry. The

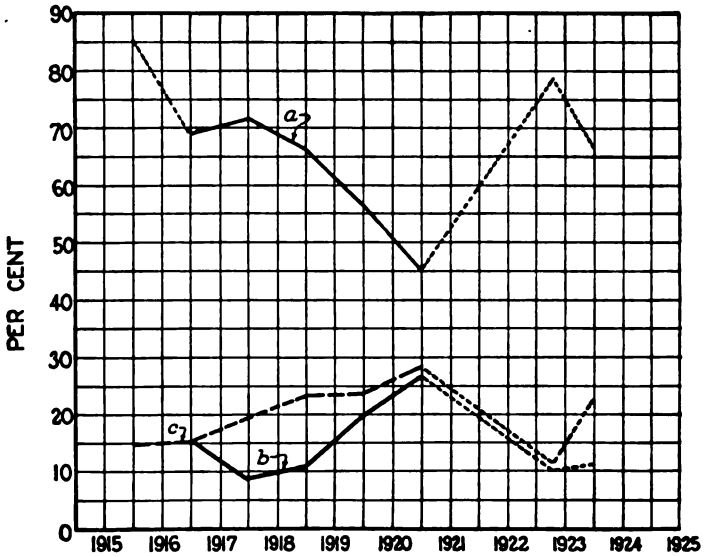

FIGURE 14.—Percentage of compensation for each department of petroleum industry: *a*, Drilling and production; *b*, pipe lines; *c*, refineries

average for compensation is 68 per cent; the average for medical expense is 61 per cent. The decline of the curve (*b*, fig. 15) for pipe-line medical expense during 1920–21 is the result of the low figure listed for total medical expense chargeable to that department. As is true for Figure 13, subsequent data may show that this point is below its true position.

SUMMARY OF DATA ON ACCIDENTS IN VARIOUS DEPARTMENTS OF PETROLEUM INDUSTRY

A study of the data in Table 1 on accidents in the petroleum industry, by departments, shows that—

1. Drilling and production operations are responsible for approximately two-thirds of all accidents in the Oklahoma petroleum industry.

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2. Drilling and production operations are responsible for a relatively larger proportion of permanent disability than either of the other departments when there is steady development in all departments. Refineries have the smallest proportion of permanent disability cases.

3. These conditions are the logical result of the greater number of men employed in drilling and production, the nature of the work, and the greater number of accident exposures involved.

4. The unit costs of compensation have fluctuated between wide limits, but the unit costs of medical expense as reported have remained relatively constant, except for 1920–21, where it is apparent that the data are incomplete for pipe lines.

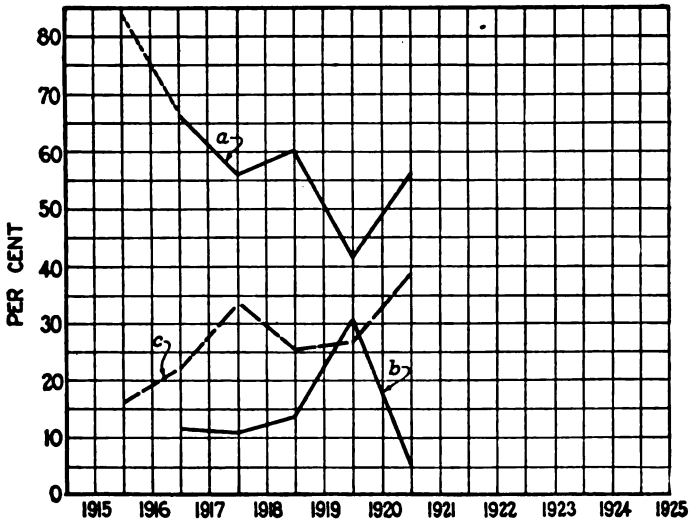

FIGURE 15.—Percentage of medical expense for each department of petroleum industry: *a*, Drilling and production; *b*, pipe lines; *c*, refineries

5. Drilling and production operations are chargeable with over 60 per cent of the total cost of compensation and medical expense paid out for accidents in the petroleum industry. The percentages of medical expense for the three departments seem to vary between wide limits; the percentages for compensation show a striking similarity to the respective percentages of compensable cases.

CONCLUSION

The data presented in Table 1 give material for further study. The figures presented should be reconciled with the whole problem of accident prevention in order to accomplish the greatest good directed toward the adoption of practice that will reduce the number and cost of accidents to a minimum.

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